SUPPLEMENT.

The Mining Journal,

RAILWAY AND COMMERCIAL GAZETTE:

FORMING A COMPLETE RECORD OF THE PROCEEDINGS OF ALL PUBLIC COMPANIES.

No. 1739.—Vol. XXXVIII. LONDON, SATURDAY, DECEMBER 19, 1868. {STAMPED .. SIXPENCE. UNSTAMPED, FIVEPENCE.

SOUTH WALES INSTITUTE OF ENGINEERS.

The ordinary general meeting of this Institute was held at the Drill Hall, Merthyr, on Thursday, Dec. 10, there being an unusually large attendance of members,

Mr. R. Bedlington (the President) in the chair.

Mr. Brigden (the secretary) read the minutes of the last meeting, which were confirmed.

The nomination of Vice-Presidents and members of the council, which took place at the last meeting, was confirmed.

Mr. Bates was appointed co-auditor with Mr. Trump, in place of Mr. Truran, now a member of the council.

The President said they had to regret the loss by death of Mr. W. Bevan, of Tredegar, who had been a member of the council, and it would now be necessary to appoint another member in his place.

On the motion of Mr. Menelaus, seconded by Mr. Kirkhouse, Mr. James Brogden, of Tondu, was elected a member of the council, in the place of Mr. Bevan.

MECHANICAL VENTILATION.

The President said the next business was to resume the discussion of Mr. G. C. Pearce's paper on "Mechanical Ventilation," which had occupied the attention of the members at several previous meetings. The machines which had been discussed in connection with the paper were Guibal's fan, Nixon's ventilator, and Struvé's aerometer. He should be glad to hear any further remarks before closing the discussion.

Mr. Williams said he was connected with some extensive mines and collieries in the North of England, where they were about to substitute mechanical ventilation for the ordinary furnaces, and he should be glad to have some information as to the best description of ventilator—whether, for instance, there were any superior to Guibal's, which they had ordered?—Mr. Pearce said he did not think there was much difference, but he believed that difference to be in favour of Guibal's—that it gave the best results with a certain amount of engine-power. Guibal's yielded over 60 per cent. of effective power. But there was one matter which they had not gone into in connection with the paper, and it would do no harm if they had some opinion as to the price of coal underground and on the surface for working purposes. A comparison of the relative cost of the fan and the furnace must depend largely on the price of coal underground and on the surface.

The President thought Mr. Pearce, in his paper, had put the price of coal required for the machine very low.—Mr. Pearce said he believed he had not put any price.—The President: What you wish to learn from the members is this, what they think would be a fair value to charge for the coal used at the machine?—Mr. Pearce: Yes, and the coal you leave underground to work the furnace?

The President: That question is important, because, as the machine uses less than the furnace, the difference in the relative cost would be considerably more if you state the coal at a higher charge.

Mr. Pearce did not see how they could make out which was the cheapest without knowing the price of the coal.

Mr. Williams said at their ironstone mines, where they raised 3000 tons of stone per day, coal was 10s. a ton at the furnace, so that it was important they should ventilate with as small a quantity of coal as possible. He noticed by the tables that with 46 revolutions per minute, and 38-horse power, they got 101,000 cubic feet of air; but if they ran the fan 74 revolutions they got considerably less. He wished to know whether they had arrived at any speed which they had proved to be the most economical? He inferred from the tables just referred to that the cheapest way would be to have a larger fan, and to work at a comparatively slow speed.—Mr. Pearce assented.

Mr. Williams enquired whether with a continued diminution of speed the increased ventilation proceeded in the same ratio, or whether there was a point where that would cease?—Mr. Pearce had no doubt there was an intermediate point which would be most economical, but he did not think they had got it.

Mr. Menelaus pointed out that the great element of waste of power with the fan was, that they discharged the air at a higher velocity than it was passing through the pit. This had been endeavoured to be met by raising the fan and enlarging the air discharge, so as to discharge the air at the top of the outlet at the same speed as it came up the pit. If they did not do this there was simply unnecessary power, which was thrown away, and that was one reason why they only realised from the fan a little over 60 per cent. An important point to be settled was the speed at which to drive the fan, in order to realise the greatest amount of power out of it. Then, as to the element of expense. If they wanted a large amount of air, it might be cheaper to work it at a loss of power, because if they drove at a low rate of speed they must have a larger fan. It was a complicated question, and he understood from Mr. Pearce that they had not yet arrived at the most economical point of speed. But Mr. Williams's question was pertinent, knowing that as they had reduced the speed they had got greater power. As to the cost of coals, he thought any loss or saving in fuel, as between the fan and the flue, should be calculated at the market value of the coal at the pit's mouth. He should now like to ask Mr. Pearce if their fan did its work satisfactorily, and without giving them trouble?

Mr. Pearce said they had very little trouble with the fan, but they had two engines, and they changed these about every month or six weeks. At first they had some little difficulty with the brasses getting hot, and they were obliged to do away with oil, and use grease and water. Then the hands of the fan and the pins got slack, but by screwing them up about once a month they had little or no trouble. But they drew up a pumping pit where the air was damp, and the machine was wet and slimy, and consequently more liable to be loose than in a dry place.

Mr. Menelaus enquired if Mr. Bates was satisfied with the economy of working the fan?—Mr. Bates said he was perfectly satisfied. With reference to their friend's (Mr. Williams) question, no doubt a larger fan would be more economical as to engine power, but if they drove a larger quantity of wind, that must travel at a quicker rate underground than if there were not so large a quantity. Suppose the fan were going at 50 or 46 revolutions, and they got a certain quantity of wind, if they increased their revolutions they did not increase the wind in proportion, and that, no doubt, was owing to the extra friction which the wind had to contend with in travelling at a greater rate underground.

Mr. Williams: There was the same fan working in the same colliery, under the same conditions, and he found that when they drove it 74 revolutions a minute they got for each horse power 1200 ft. of air, but if they reduced the revolutions to 46 they had 2500 cubic feet for each horse power. He wanted to know if there was a probability of that increase going on in the same ratio if the fan were brought down to 20 revolutions?—Mr. Bates would not say there was no probability of keeping to the same ratio. If when they increased from 46 to 70, they meantime made the airways in the pit proportionately large to the extra revolutions, probably they would have the same results; but if they increased the revolutions, and kept to the same sized airways, it would be impossible to get the same result.—Mr. Williams pointed out that the great loss seemed to arise between 46 and 60 revolutions, and between 60 and 70 it was insignificant. At 46 they had 2500 ft. for each horse power, at at 60 they had only 1500 ft., and at 74 they had 1200 ft.—Mr. Pearce said, if they looked at the water-guage they would see the reason for that.—Mr. Williams said, at 46 it was 1½ inch water-guage.—Mr. Menelaus observed that with an increased water-guage they were drawing an attenuated medium; and if to the loss of power by getting rid of the air at a higher velocity than necessary they added the attenuated column, the loss was enormous.—Mr. Pearce reminded them that with the furnace they could not by firing as hard again get double the quantity of air.

Mr. Williams said, when he was at Dowlais, Mr. Dickinson, Mr. Atkinson, and other gentlemen were making experiments with the upcast shaft, and that when they increased the heat of the stack above the point for melting lead the air diminished, and when they reached the heat for melting cast-iron the quantity of air passing through the grate was small indeed. The process was reversed, and as they lowered the heat to 600° or 700° the air coming up increased.—Mr. Menelaus said it was the same law. They got a more attenuated medium and smaller work.

The President said that the statement of Mr. Williams was most important, and asked if there were any figures relative to the matter?—Mr. Williams said the figures were at Dowlais, but he would tell them the whole thing as well as he could. Mr. Atkinson, Mr. Dickenson, and one or two others, were at Dowlais, and they propounded the theory. He (Mr. Williams), Mr. Menelaus, and others, argued the point, and had the best of the argument, but though they had the best of the argument, yet next day on an appeal to facts the facts beat them. (Laughter.) They closed all the furnace through which air could pass, except the grate. They put a wooden box through which the air must pass, and fixed three or four anemometers in the box out of the reach of the heat. Whether the anemometers were correct or not they were relatively correct. They started with the stack cool. The furnace was lit at five o'clock, and as the stack got hotter they melted silver, and on to cast-iron. As the stack got hotter the anemometers went quicker, and the air passing through the grate increased. At 600° it was stationary, at 700° it was less. They melted successfully zinc, copper, silver, and cast-iron, and then the quantity of air was insignificant. The conclusion they arrived at was that the enormous expansion of air produced such a drag on the side as to prevent the upward current. They then left some persons who had no record of the figures taken that day to work the thing backward. These persons brought their figures next day, and though he did not mean to say it was anything more than a rough experiment, and probably the figures were not perfectly agreed, yet they were wonderfully like the results which had been produced the day before.

The President: That is the same as the underground flue—what is called the "furnace paradox," is it not? And you agree there is such a thing as the "furnace paradox?" that is, when you reach a certain heat there is no more air.—Mr. Menelaus said it was just one of those cases where practical men were ignorant of scientific facts, and when at his dinner-table Mr. Dickinson propounded it as an established fact that at a temperature of 600° in the upcast shaft there was most air he was a little startled. But, as far as a rude experiment went, it was certainly shown at Dowlais that at a temperature of 600° the chimney drew more air through the grate; they closed the grate and opened the door, but, whichever way, the quantity of air going up the chimney was greater at 600°. It was an interesting fact, because he came to the conclusion that it required a low temperature to produce an effective draft for a furnace. He thought it was perfectly clear, because with a high temperature they had not only a greater drag and higher velocity, but an attenuated medium, and conducted a fewer number of particles of air up the chimney. In the one case they had a dense medium at a pressure of 15 lbs. to the inch, and on the other hand an attenuated medium through the same area; this must travel at a higher velocity than the denser, and consequently there was a greater drag. And that was just the point—600°—at which they got the greatest advantage.

The President said the point seemed connected with mechanical ventilation in this way. They had been anxious to discuss that subject, because they had always been told this—that there was a point in the furnace ventilation beyond which they could not get, and that the advantage of machine ventilation consisted in the fact that it gave them a comparatively unlimited power at their disposal. But it seemed there was a limit to the power of the machine. It appeared that mechanical ventilation, though it might be capable of doing so, yet that hitherto it had not given them a greater amount of cubic feet per minute than the furnace. But he thought it had been proved in the discussion that they could get a given power at less expense by the machine than by the furnace.

Mr. Pearce, in reply to questions put, said they had not tried the fan with less than 40 revolutions. He agreed that possibly 30 revolutions might be better if they had upcast sufficient.

Mr. Williams said that no coal which they could get was worth less than 10s., he thought it was worth 11s.; and the mere cost of laying a larger upcast, and making the airways large enough, was nothing as compared with the cost of coal. If 20 revolutions were sufficient they would make their outlets larger to suit.

In answer to the President, Mr. Pearce said he did not advocate more than 50 to 60 revolutions.—The President: And that would give an amount of ventilation which would not suffice for some collieries.—Mr. Pearce: Yes; but you are not limited as to the size of the fan. You can make the fan bigger.—Mr. Williams: The remedy would be another fan and another ventilating pit.—The President: It is easy to get, I admit.—Mr. Menelaus: He is thinking of his own case.

The President: We were speaking of the comparative advantages in the same pit of the fan and flue. Mr. Pearce's question was this—are we in estimating the cost of the fan as against the furnace to take the coal at the actual cost to the proprietor or at the market value? Now, if there is a saving in the amount of fuel consumed in the fan over that of the furnace the difference would be so much greater if the coal is charged at the market value.

Mr. Menelaus and other members expressed a decided opinion that it should be charged at the market value.

Mr. Davies (Crumlin) said, with regard to the loss of power in Guibal's fans, he understood that the Guibal's fan had one orifice or outlet, which was adjustable by a movable shutter, and as there was no fixed area for that orifice it was arrived at by experiment. Now, if they got the greatest amount of power at 46 revolutions, and if by increasing the velocity from 46 to 60 they only got, as was shown, 54 per cent. instead of 63, then he wished to ask this—Whether that orifice had been moved, or the outlet increased in the same proportion that the speed was increased? If not, it struck him that the great amount of loss must be by taking up the air, and forcing it through that contracted orifice.

Mr. Pearce thought the amount of opening was stated in the table.—The President: Did you experiment at the increased speed upon the opening as to which would get the best result?—Mr. Pearce: We tried the shutter where we could find it best before we made the experiment.—The President: And you opened it more to suit the increased velocity?—Mr. Pearce: Yes.—Mr. Davies: That is not shown here, I think. I saw an opening, but I took that to be the opening in the stack.—Mr. Bates: The shutter was stationary in this experiment.

Mr. Wilkinson, in reply to the President, said he considered that where they had 50,000 to 60,000 cubic feet he thought the shutter was of no use, and he detailed the experiments which led to that conclusion. He thought it might be useful with a small quantity of wind.—The President: I understand you to say that the shutter may be quite open from 50,000 cubic feet per minute upwards?—Mr. Wilkinson: Quite open. You cannot tell any difference after passing 3 ft. 6 in.—The President: But in making experiments up to 50,000 cubic feet you opened the shutter more with the increased velocity?—Mr. Wilkinson: Yes; all the way to 3 ft. 6 in.

Mr. Bates, in answer to the President, said that when with 46 revolutions they had 100,800 cubic feet, there were 95,888 in the returns. They consumed about 50 tons of coal per week, about one-seventh of which was large.

Mr. Pearce said they used a very bad quality coal.

Mr. Menelaus enquired of Mr. Wilkinson what proportion the 3 ft. 6 in. opening in the shutter bore to the bottom of the chimney connected with the fan? Because if 3 ft. 6 in. opening was anything like the same area as the bottom of the chimney it was clear that they might open the shutter to 5 ft. or 6 ft., and they would have the precise conditions under which the fan would be worked if closed at 3 ft. 6 in.—Mr. Wilkinson: I say from 3 ft. 6 in. with a large quantity of wind the shutter is of no use; but with a small quantity I believe it would be of use below 3 ft. 6 in.—that is, because that opening is near about the same as the bottom of the chimney.

Mr. Menelaus concurred; but he held that Guibal's opening of the shutter was an improvement on Nasmyth's open fan. That was admitted on all hands, and Mr. Wilkinson did not upset it, because he admitted that driving the fan at a low velocity he found it advantageous to open the shutter with the increase of velocity, until he arrived at an opening the measure of the area at the bottom of the outlet. He thought Mr. Wilkinson's remarks were a strong argument in favour of, and not against, the shutter.

Mr. Pearce said the shutter did not make so much difference to the quaintity of air as to the power of the engine to drive the fan. They got nothing by opening or closing the shutter, except that, with some quantities of wind, less engine-power was required on closing the shutter.—Mr. Menelaus: It is the relative power of the engine to the work done. Mr. Menelaus explained to the President that by the "chimney" he meant the outlet from the fan. The only value of the shutter was to utilise the largest amount of power out of the steam-engine. If they did not care about a ton of coal it did not matter about altering the shutter. If they did not care whether they had 20, 30, or 60 per cent. of power they could dispense with the shutter, and introduce Nasmyth's plan. But the value of the shutter was to economise the coal, and it would require some nice experiments to prove the value of opening and shutting.

Mr. Bates said they used about 50 tons of large coal with the furnace at the Gethin Pit. That produced from 90,000 to 100,000 cubic feet with the fan, and, getting 100,000 cubic feet, they consumed the same quantity of coal, only about one-seventh was small.

The President: Then the difference is as between the relative cost of large and small coal?—Mr. Bates: No; the quantities are different. In the furnace you get 90,000 to 100,000, and in the machine over 100,000 feet.—Mr. E. Windsor Richards was surprised to find that at the speed of 70 revolutions there should be any hitch in the engine. They every day saw engines going 100 revolutions per minute with a hitch, with ample bearings, and white metal used. But Mr. Pearce's question had not been answered as to the price of large and of small coal, and until that was done they could not tell the relative cost of the two modes of ventilation.

The President said the market value would be different figures, according to the quality.—Mr. Pearce said that, as to the speed, they had gone 75 revolutions, and he daresay they could continue at that. As Mr. Richards said, it was only a matter of surface and bearings, and good fittings. But they found 50 to 60 the more economical speed, and they had no trouble.

Mr. Thomas (Rhymney) enquired of Mr. Bates the comparative depth of the two pits where machine and furnace ventilation were respectively employed? The great advantage of mechanical ventilation was that they could bring a large quantity of wind from shallow pits.—The President: At a greater depth the flue holds its own.

Mr. Bates said the upcast of the furnace was 90 yards, and the

downcast connected with it 130; the upcast for the fan was 130; there was a downcast at the same depth, while another was 200.

Mr. THOMAS said a great advantage was that they could apply the fan on the surface—on the crop of the seam—anywhere.

The PRESIDENT: The same with the flue, but there it is not so effective.—Mr. LEWIS thought they should know the length of the airways, the number of splits, and the precise condition of the furnace and ventilation before they could estimate the relative cost.

The PRESIDENT: It has not been stated that this machine produces as high a quantity of air as is produced by furnaces in the South Wales district.—Mr. THOMAS: Yes, taking the depth of shaft into consideration, the furnace had an advantage in deep shafts.

Mr. WILKINSON said the machine had not been applied to any deeper shaft than theirs, which was 300 yards.

Mr. BATES (replying to Mr. Lewis) said if they looked at the proceedings of the first meeting, where mechanical ventilation was discussed, they would find he had given a comparative statement between Struvé's ventilation and the furnace at Risca. The experiments were taken at the identical places. The upcast shaft was 70 yards; with the furnace they got 28,000 cubic feet per minute, and with Struvé's ventilator they got it up to something like 50,000. In answer to a further question, Mr. Bates said that at Cyfarthfa, where the machine was applied, the air had to travel a greater distance than where the furnace was in use, but there was not much difference. In his opinion mechanical ventilation was the best, under all circumstances, except where the pit was of a very extraordinary depth.

The discussion then terminated.

The PRESIDENT remarked thas the paper had been a valuable one, and had elicited discussions containing very valuable information.

MR. BASSETT'S PAPER ON "PATENT FUEL."

The PRESIDENT said the next business was the resumption of the discussion of this paper. Mr. Bassett was unable to be present, but he had written to say he wished it stated that within the last few weeks the directors of the London Patent Coal Company had sold their interest in the patent to the Compressed Coal Company, at Lydney, who had decided to reduce their royalty to 6d., 5d., and 4d. per ton, depending on the quantities manufactured in any one year. They were about improving their machinery, which would enable them to produce 50 or 100 tons in a day of 10 hours, and it was hoped they would soon be able to state that they made the blocks waterproof. He (the President) had also had a rather long letter from Mr. Hoskold, which he might summarise by saying that Mr. Hoskold demurred to Mr. Bassett's proposal to use starch from potatoes in the manufacture of patent fuel, and that he was about to produce patent fuel by a process of his own, which he was about to patent. He would communicate the result to the members on another occasion.

Mr. BIRKBECK, in reply to the President, said that Mr. Brogden was making some experiments at Tondu, of which he would probably be able to give information at the next meeting.

DAVIES' SELF-ACTING STEAM STRIKER.

The adjourned discussion of this paper was then taken.

The PRESIDENT enquired what saving Mr. Davies considered would be effected by adopting the striker?—Mr. DAVIES said the smallest smithies where the striker had been adopted were those where there were four fires, to each of which there had previously been a striker and an assistant. When the steam-striker was applied two of the men had been still retained, not so much on account of the striking or doing heavy work, but for taking it in and out, and so on. If they went into the question of the economy effected by the striker, it had been found that practically there had been a saving of about 66 per cent. as compared with the cost of doing the work by hand. For instance, work which had cost 1s. 8d. had been let at 7d., and the men who worked it at that price could earn more money than they did by hand.—The PRESIDENT presumed the saving would be the greater in large establishments.

Mr. DAVIES did not think there was any limit to the classs of work to which it might be applied. Beyond that, he might state that the object of the steam-striker was not to dispense with the steam-hammer, but to do a certain class of work which the steam-hammer in its ordinary form could not touch, such as tapered and angular forgings, moving in a circle, or, in fact, striking blows in any given direction. For instance, they supposed it was necessary to get the greatest effect on the iron while it was hot, and they knew that to do that they must get the maximum effect of the hammer to bear on it while it was in its hottest state. If they wanted to get at the true comparison of the effect of the strike it was absolutely necessary to take the case of an ordinary fixed hammer, and they might suppose it to be a hammer of 3-ft. stroke. If they put under that hammer an ingot 18 in. thick they not only take away half the useful effect, but they took it away at a wrong time—that was, supposing the effect of the blow to be, as was generally understood, by multiplying the weight of the hammer into the square of its velocity in feet per second at the moment of impact, because falling through half the space it had only two-thirds the velocity. And that was without taking the question of economy of steam into account at all, because if they did they would find that working an 18-in. stroke with a 3-ft. cylinder they would sacrifice 25 per cent. of steam at each stroke. Now, to take a steam-striker for comparison—namely, with a hammer of 150 lbs. weight when at rest on the face of the anvil. This would correspond to a "C" size striker, which was actuated by a steam-cylinder, 6-in. stroke, and hammer-arm of 4 ft., moving through 54°. As the effective height of the fall would be approximately the sign of that angle, they would get 3¼ ft. as the effective height of the fall, which would be near enough to call 3 ft. Now suppose, as before, that they had a piece of iron 18 in. thick on the anvil, it was simply necessary for the smith to open the hydraulic cock, the striker being fixed, and the hydraulic arm was raised through a space of 18 in.; it was, therefore, capable of maintaining its full effect on the iron while in its hottest state; and, consequently, the ingot was penetrated to its core. Then the advantage of working with any number of anvils or swage blocks might be readily seen by a comparison of the strike with an ordinary direct-acting fixed hammer. Suppose, for instance, six smiths to be occupied on various classes of work, such as to necessitate the changing of dies or swages once or twice a day. If those six smiths were working with a fixed hammer, and supposing they had to change the dies once only in the day, what would be the result. Assuming it took half an hour to change the fixing or swage, they found there were six smiths that could not during that period go on with their work, being a loss of time equivalent to three hours for one man. If they paid 5s. a day wages that would be three hours at 6d.=1s. 6d. Supposing these to be attended by three helpers at 3s. 4d. a day that would be 6d., which added to the 1s. 6d. made 2s. a day, 12s. per week, or 31*l.* 4s. per annum, as the total cost of changing and fixing the swages. Now, that was a direct saving which would be effected if the men were engaged on various classes of work, and which, so far as he was aware, could not be effected in any other way. But as a dozen different swages might be fixed in the circle round which the striker turned, it would be seen that the whole of that time, equal to 31*l.* 4s. per annum, might be saved; the dies being permanently fixed, it was only necessary to swing the hammer round to bear on any die or swage, which was done while the heat was going on. And as the space between the swages or anvil blocks admit of forming wells by fixing cast-iron pipes vertically in the floor, these might be easily used for up-setting shafts, bars, axles, &c., by simply bearing the strikers round to work vertically on the ends of the bars when standing in the well, which was a great advantage when any quantity of such work had to be done.

Mr. MENELAUS said they had present a distinguished old-fashioned hammer maker, whom they would be glad to hear.

Mr. C. H. CARBUTT (Bradford) said he had not intended saying anything about the steam-hammer. He had, however, seen the striker working in the Paris Exhibition, and was much pleased with it. It was well-schemed, and did great credit to Mr. Davies. For bending angle-iron it was most useful; but when Mr. Davies compared it with the steam-hammer, his comparison was out of place. In his own plan he did not show any dies, and, therefore, he (Mr. Carbutt) did not see how he could compare it with the steam-hammer. Most steam-hammers were worked with loose swages, the dies not being moved out of the hammer. Neither did he think it would take half-an-hour to move the swages from the fixed hammers; if it did he should get rid of his men.—The discussion on the paper then closed.

NEW MEMBERS.—The PRESIDENT stated that he had just received the report of the scrutineers, and he had to announce that the following gentlemen had been admitted into the Institute:—Mr. Hugh Begg, colliery manager, Glamorgan Coal Company; Mr. Osman Barrett, colliery proprietor, Mitcheldean; Mr. John Warren, engineer and land surveyor, Newport; Mr. Morgan Reynolds, mining engineer, Dynevor Collieries, Neath; Mr. G. F. Adams (graduate), mining engineer, Cardiff.—Associate: Mr. L. Davis, colliery proprietor, Cardiff.

OVERWINDING, AND ACCIDENTS IN SHAFTS.

The PRESIDENT stated that the next business was Mr. Fairley's paper on this subject, read at a previous meeting, and he thought it would be well to include in the discussion the paper by Mr. King, "On King's Patent for Prevention of Accidents in Colliery Drawing-Shafts, and Overwinding."

PREVENTING SHAFT ACCIDENTS AND OVERWINDING.

This paper described an apparatus invented by Mr. John King, and consisting of a safety-catch and a disconnecting hook. The catch consists of four cast-iron toothed cams, which are fixed in the same position, and act in the same manner, as the eccentrics on White and Grant's safety-cage. The outer ends of the cams are pulled off the guide-rods, when the winding-rope is tightened, by small connecting rods attached to a check chain, and there are double-hooked springs, which pull the cams on to the guide-rods in case of breakage. The disconnecting hook is a modification of, and acts in the same way as, that of Mr. E. Ormerod, which has for some time past been in use in the Manchester district, and created much attention when first described in the *Mining Journal*. The advantage which Mr. J. King claims for his apparatus is that its weight does not exceed 1 cwt., including hook for detaching the chair to prevent overwinding; that the cams and springs are so placed as to be applicable to all shafts with wooden conductors, without any alteration; and that the apparatus can be quickly fixed, often in a few hours, at a cost of 4*l.* to 6*l.* per chair. No expense in stores or attention is needed to keep it in working order, other than keeping the chair top clean. The springs come into play every journey, and any derangement cannot fail to be at once detected.

Mr. King attended with a model of his patent; and Mr. Ormerod also exhibited a model of his invention to prevent overwinding.

The discussion was mainly of a conversational character, and would be unintelligible apart from the models, to which frequent reference was made, illustrative of the replies to questions propounded to Mr. King and Mr. Ormerod.

Mr. KING submitted that his invention would prevent accidents from the rope breaking in the shaft, and Mr. ORMEROD, on the other hand, stated his was simply applicable to the prevention of overwinding. He said that they and others had tried inventions to catch the cage when ropes broke, but, so far, he believed with only partial success. He knew three cases in his neighbourhood where the thing had failed, and the modern application of wire-rope guides had rendered the difficulty all the greater, especially on account of the wire being greased.

Mr. BIRKBECK said that at Tondu they had for some years employed Owen's safety-cages; they had three accidents, and in each case the rope broke between the head-gear and the engine, close to the engine-house, and the catch acted as it was intended to do. He described the particulars of the accident in question, giving the weight of the trams, &c.

Mr. ORMEROD said Owen's patent was adopted in the cases to which he had referred as failures. He thought the difficulty would be much diminished if everybody would employ wooden conductors instead of wire ones.

After some further conversation, in which Mr. KING instanced one or two cases in which his patent had effectively answered in time of accident in the shaft, the PRESIDENT said he had received a letter from Mr. Fairley stating that his suggested arrangement to prevent overwinding would not apply where the average speed exceeded 12 feet per second.

The discussion on Mr. James's paper on "The Assurance of Miners," and that on Mr. Morgans' paper on "The Brendon Hills Spathose Iron Ores and Mines" was adjourned.

THE BRENDON HILLS SPATHOSE IRON ORE AND MINES.

This was a paper by Mr. MORGAN MORGANS, giving a description of the spathose veins occurring in the Brendon Hills—the opening and exploring of the greater part of which the writer conducted from 1858 to 1867, a period of nine years. The Brendon Hills ore gives upon analysis, in round numbers, 44 per cent. of protoxide of iron, 12¾ per cent. of manganese, and nearly 39 per cent. of carbonic acid (34¾ per cent. of metallic iron). There is enough manganese to yield a spiegeleisen containing 20 per cent of that metal if it could be successfully reduced and alloyed with the iron in the blast-furnace. Spathose ores, though extensively worked in Prussia and other countries on the Continent, where they are generally converted into spiegeleisen, are at present only worked at two places in England—the Brendon Hills, Somerset, and Weardale, Durham. There are, however, other similar deposits in this country. There is one at Exmoor, in Devon, and the writer has seen several in Cornwall. The writer understands that the spathose deposits at Weardale are in carboniferous limestone. No traces of organic remains have been yet observed in the clay-slate of Brendon Hills, nor have any beds of limestone been found near the spathose veins. Mr. Morgans commenced with the Colton Pits, at the eastern end of the deposit, and described the several workings until the western extremity, or Eisen Hill, was reached. The remarks upon the mines illustrate the capricious nature of the Brendon Hills spathose veins, and the writer concludes that the veins are not of igneous origin, because the carbonic acid remains in combination with the protoxides of iron and manganese, and the walls of the veins show no trace of igneous action whatever; and that they were not deposited contemporaneously with the killas, because the lodes are not parallel with the clay-slate, but generally with the cleavage, and from many other reasons. It is believed that no spathose veins equal to those of the Brendon Hills for magnitude and purity of ore are known in this country. Mr. Morgans suggests the best modes of dealing with the ores to secure the best results, and furnishes an abundance of analyses to show the ordinary composition of spathose ores.

A paper by Mr. E. J. Beor on "The Pomerance Lignite Mines," in Italy, was taken as read. It will be discussed at a future meeting.

The proceedings then terminated, and the members afterwards dined together at the Castle Hotel.

MANUFACTURE OF WHITE LEAD DIRECT FROM THE ORE.—The Dutch process of making white lead being very injurious to the workmen, has, in many places, given place to Thenard's process, which consists of a solution of a soluble salt of lead, and by passing carbonic acid gas through it, the lead is precipitated as a carbonate. This process may be executed on a very small as well as on a large scale, and requires the following steps:—First, a saturated solution of acetate of lead (lead sugar) is made, either by dissolving this salt in water, or by heating metallic lead with pure vinegar; this solution is boiled with oxide of lead (litharge) till it cannot dissolve any more of it; one part of pure strong wood vinegar (pyroligneous acid) will dissolve a little less than one part of litharge (oxide of lead), and form a neutral acetate, when dissolving twice that quantity of litharge in it (correctly 60 parts of acetic acid to 112 of litharge, one atom of each), we obtain a so-called subacetate, a basic solution, which colours litmus-paper blue, and when dissolving three times the amount of litharge the solution is saturated, and the excess of lead above the neutral solution will be readily precipitated as carbonate of lead by passing carbonic acid gas through the solution, till the solution becomes neutral again, or even acid. As soon as the precipitation is completed, the liquid is left to settle, the supernatant neutral acetate of lead solution is decanted off, and boiled with another dose of litharge; thus a limited amount of acetate could be used for an indefinite period, if there were not unavoidable losses during the process, which have to be supplied from time to time with fresh acetic acid. Several modifications of Thenard's process have been proposed, but, perhaps, the most practical is a recently patented method, according to which it is proposed simply to use an impure ore of lead, of such a kind as is soluble in acetic acid, boil it with the acid, decant and filter the solution till clear, and then precipitate with carbonic acid. A common lead ore of this class is a mineral carbonate of lead of a reddish-brown or grey colour; it is abundantly found in various parts of the country. Dr. Van der Weyde, of New York, has recently patented an apparatus, by which the wood vinegar necessary for the solution of this ore could be distilled from the wood at the mine, and the residue of the distillation, the charcoal, while hot in the still, was converted into carbonic acid gas, by simply blowing a current of air through the still, as soon as the volatile products were driven off by the distillation; this carbonic acid gas, after passing through cooling and washing tubs, is used for the precipitation of the carbonate of lead, the whole process thus being accomplished in one apparatus and one operation. By this method of using the lead ore, the labour of reduction to the metallic state is entirely saved, a labour required when following either the old or so-called Dutch method, or when using the lead sugar, or when dissolving in acetic acid the litharge which is manufactured from the metallic lead. Generally the white lead obtained after the French method by precipitation, has not the body, or else does not cover so well as that prepared after the old Dutch method: the cause is revealed by the microscope; the precipitated white lead consists of little semi-translucent crystals—the Dutch white lead—out of opaque white grains, but later improvements in the French method have overcome that difficulty to a great degree; they consist in preventing the formation of these small crystals by the use of nitric, sulphuric, and hydrochloric acids, and thus form a compound which consists not only chiefly of a carbonate, but also of a sulphate and chloride, which last two, by themselves, are inferior to the carbonate, but when combined in the formation of the precipitate, appear to improve the pure carbonate in a manner not yet precisely explained.

ROCK-BORING MACHINES.

At the ordinary monthly meeting of members of the London Association of Foremen Engineers, on Dec. 5 (Mr. Joseph Newton, of the Royal Mint, President, in the chair), Mr. JAMES IRVINE, of Messrs. Simpson's Engine Works, Pimlico, read a paper "On Rock-Boring Engines." The author, after some preliminary observations as to the ancient modes of cutting through rocks, said that the first rock-boring engine of any note, which he proposed briefly describing, was Bergström's. This is, or was, recently employed in the mines of Sweden. This machine, said Mr. Irvine, consists of a cast-iron cylinder, 4½ in. in diameter, with the boring tool fixed into the end of the piston-rod, which has a socket to receive the same, and the tool, or drill, is made to revolve by the action of a worm-wheel working into a screw, or worm, driven by the fly-wheel shaft. The engine, for it is nothing more than an ordinary engine, is worked by compressed air or steam, and has a valve fixed upon the cylinder. The slide valve is made in the form of a small piston, and on the end of the valve spindle is keyed a cross-head, which by means of two connecting-rods gives motion to the fly-wheel, and thereby causes the boring drill to revolve. The machine is supported, or held, in position by screwed stays and nuts, which enables the drill to advance or retreat. The advance motion is all done by hand, which is rather inconvenient, as it must require one man at least for every machine at work. The machine can be fixed in any position, but it requires three men to do it, and this makes it rather expensive to work. The engine, as I have said before, is worked by compressed air, and as the air-pump is of rather a novel design, perhaps it would not be out of place to describe it. It consists of two cast-iron barrels, each 15½ inches in diameter, and 8 feet long, and connected by a chamber at the base. The upper end of the barrel has a valve-box with two valves, one opening inwards for the admission of air, and the other outwards for the delivery of air into the accumulator. In one of the barrels is fitted a piston, or bucket, which is made to work up and down, and to make sure that every particle of air may be delivered at each stroke of the pump, and also to keep the barrels from oxidising, a quantity of water is placed inside the pump, so that at each stroke the water entirely fills up the valve chamber, and thus expels the whole of the air from the pump. The second barrel has no bucket in it, but is only filled with water, which rises and falls as the other bucket goes up and down, so that this water also forces out all the air from the barrel and valve-box at each stroke of the bucket in the other barrel. The stroke is 7 feet, making four strokes per minute, and it compresses the air to about 15 lbs. per square inch; it will take from 6 to 7-horse power to drive it, although it will only supply sufficient air for one engine. It is, perhaps, unnecessary to say more of this machine, and I will revert to one of more recent date, known as Low's engine, and this appears to be nearer the thing required by the proprietors of our mines and quarries, still it demands much improvement to make it exactly what it ought to be. It is much too complicated, and has far too many working parts. The stand upon which it is fixed is very cumbrous, so much so, indeed, that a small engine is necessary to work it about. I am sorry I have not got a drawing of it, as you could then have followed my description more easily.

Low's engine consists of two cylinders, one large and one small, the large one for doing the work or striking the blow, and the small one for returning the piston to its first position, which is done by keeping a constant pressure of air in the passage of the small cylinder; this pressure, of course, must be overcome, and power is, consequently, wasted while the large one is doing its work. The admission and exhaustion of the air is obtained by an ordinary slide valve, worked by a number of levers, pins, and connecting rods, which are liable soon to get out of order. They are worked in their turn by slightly inclined pinions fixed upon the piston-rod, and which begin to work the valve at the termination of each stroke, so that the full pressure may be given to the blow. The division between the two cylinders is bored out to fit the piston-rod, and packed with a cup leather. The piston-rod is hollow, and of a larger diameter than usual. It has an internal screw, cut from end to end, of about 3-in. pitch. The piston nut, which is made to fit the internal screw, also holds the boring tool, and allows it to go forward. The piston and tool advance about ¾ in. for every ¾ in. that the drill bores, so that instead of advancing in a regular manner it jumps ¾ in. ahead at intervals. The progressive motion is effected by having a constant pressure of air on the piston, but while the drill bores ¾ in. the piston nut and tool are prevented from turning or advancing; the piston-rod, in fact, cannot move forward until released by the use of levers and catches, and after the drill has turned the allotted ¾ in. I had almost forgotten to explain the way in which the turning is effected. On the outside of the piston-rod are cut four grooves, two of which are a littled curved throughout the stroke; these are connected by two ratchet-wheels and pawls, which keep the piston-rod in whatever position the groove may turn, so that at every stroke of the piston it will make part of a revolution. This machine has so many working parts that it must be very liable to get out of order.

I now come to Mr. Dœring's engine, which possesses many advantages over those described. In the first place, the working parts have been reduced to a minimum, whilst, as you will remember, the machines previously described have 12 or 14 of these. This engine consists of a gun-metal cylinder, bored out to a diameter of 2¾ in., or an area of about 6 square inches, and is fitted with a steel piston. It is worked by compressed air, at a pressure of from 25 lbs. to 30 lbs. per square inch; thus, 30×6=180 lbs., which is the pressure or blow upon the drill every stroke of the engine, which makes 300 strokes or blows per minute. The piston and rod are forged in one piece. The piston-rod has a number of holes bored in it, the reason for which will be explained. In the end of the piston-rod is bored a hole, for the reception of the boring drill, which is fastened with an ordinary key, having a collar or movable nut between the key and collar of drill; when, therefore, the key becomes slack it is only necessary to turn round the nut, and the key becomes as good a fit as when it left the shop. No other packing is used beside small metallic rings, which keep the piston-rods much tighter, and with two-thirds less friction than arises from hemp packing. The piston packing is, indeed, on the method known as Ramsbottom's, but instead of having the springs cut straight through they have been made with a projection on one side, to prevent their turning round and coming in contact with the air ports of cylinder. The piston is worked to and fro by the compressed air, admitted by means of a small circular slide valve

a most ingenious contrivance, and which entirely dispenses with all links, levers, pins, connecting rods, &c., which are a drawback to the other engines named. This valve is entirely self-acting, and almost infallable in its performance. It is worked entirely by compressed air.

I will now proceed to explain how the drill is made to revolve. In the centre of the piston and rod is a square hole, into which is fitted a ¾-in. square steel bar, and upon one end of this bar is fixed a steel ratchet-wheel, having 24 teeth. There is a small cylinder, 1¾-in. diameter, cast upon the end of the large or main cylinder, into which is fitted a small piston, having attached to its rod a pawl, which works the ratchet-wheel. When the main piston passes beyond a certain point the air rushes into the small cylinder, and drives this piston forward, thereby causing the pawl to turn the ratchet-wheel one tooth. The small piston has a constant pressure of air upon the front end of it. When, therefore, the main piston makes its return stroke the air is exhausted from behind the small piston, and drives it back to the first piston. There it remains until the main piston allows the air to get behind it again, when the ratchet and drill go round another tooth. The ratchet having 24 teeth, it makes the drill revolve one revolution in every 24 strokes, and at every stroke the drill will revolve 1-24th of the circumference of the hole to be drilled. The exhaust air from behind the small piston escapes into this recess round the main piston-rod, and from thence into a small hole bored up the piston-rod, whence it passes into the atmosphere.

The next movement to be explained is the method of feeding the drill into the rock. In the first place, the machine will bore a hole 2 ft. 6 in. deep; therefore, it is necessary to have something which will give it a steedy downward motion. Whether the rock be hard or soft, the downward motion must be in accordance with the nature of the material to be acted upon—that is to say, if the rock be hard the feed must be slow, and if the rock be soft the feed then must be fast. It is also essential that the feed should be regular, and, at the same time, entirely self-acting. The engine stands—or, more properly speaking, hangs—upon two guide-spindles, one of which is screwed from about 18 in. of the end, and with a long bearing nut fitted to the same. Upon the end of this nut is fitted a ratchet-wheel, which is made to revolve in precisely the same way as the one which makes the drill revolve, with this exception, that the ratchet-wheel cannot move until the main piston and drill have gone beyond a certain point. For until the drill has gone some depth into the rock the main piston cannot get beyond the port-hole which supplies the air to the small piston, and which itself is attached to the ratchet-wheel. If the rock be hard as granite the drill will, perhaps, make from 300 to 400 strokes before the feed begins to act; but if the rock be soft, then the feed-cylinder will be continually at work, for the port is so arranged that the main piston and drill must travel a certain distance before any air can be admitted behind the small piston which works the feed ratchet-wheel. If the rock be soft the drill will travel beyond this point every stroke, and will, therefore, be continually feeding the drill downwards. I have now shown, I think, all the movements of the machine, and the simple manner by which they are obtained; and, as there is nothing but metallic packing in glands and piston, they are made to work with great ease and freedom.

It will be well now to explain how the machine or engine is held in the quarry or mine. The manner of holding it in its position is exceedingly simple, and at the same time most effectual. The stand which holds the engine is very light, and easily transported from one place to another—in fact, two men, with the aid of a hand-spike, can take it up and carry it to any place required. Although it looks very light, it is yet quite strong enough to hold the drill in its position. On the base of the upright which holds the engine is a round plate, slightly conical, and upon which is fixed a circular piece of India-rubber, ¾ in. thick. Now, if it is wished to bore a hole, or any number of holes, all that requires to be done is simply to place the stand upon the rock; it makes no difference how uneven or how rugged the surface may be. It is only necessary to take a piece of loam, or soft clay, and plaster the India-rubber edges all round, so that no air can get beneath the India-rubber. The stand must then be put down upon the place required, and a small cock, which connects with the air-pump and bottom of stand, is opened, and a vacuum created underneath the India-rubber, and if there is no leakage from without, which can easily be prevented with the loam, or soft clay, previously mentioned, the stand will be quite steady and firm.

In boring holes in rock it is indispensable to have a supply of water, or a small jet constantly playing into the hole, not only for the purpose of making the drill cut better, but also for clearing out the borings from the hole, and it is also requisite for the water to be under pressure; this is obtained in the following manner:—Two small tanks and one cistern, common to both, are provided; one tank, we will suppose, is full of water, and the other is in the act of being filled from the cistern. In the full tank is fixed a small tap, which communicates with the main air-pipe; this, when open, allows the air to press upon the top of the water, and thereby rush out at the bottom of the tank at a pressure equal to that contained in the air-pump. The effect of having two tanks and a cistern is that one is always ready for work when the cistern is full. When one tank becomes empty the other in the meantime has been filling, and by shutting one set of cocks and opening another (alternately) you have always a supply of water, and that under pressure. The stand spoken of is only for boring holes in a vertical position, or at least a very slight angle. Mr. Dœring has another very ingenious and substantial stand for fastening the engine upon when required to drive a heading in a mine, or for making tunnels, and it is so constructed that there is no position you could point out but what I could bore a hole with it; it will turn into any position with the greatest ease by the power of one man, but since I have had no time to make a general drawing of it I think it would be better not to attempt a description of it.

Another point that is left for me now to describe is the boring-drill, the form of which differs slightly from that of those formerly used by hand. You will observe the drill point is made entirely from the smith's hammer, nothing being done to it after leaving the smithy. Its cutting end is of the form of a Z, and Mr. Dewar has forged some excellent ones. The air-pumps for supplying the rock-boring engine with air consists of three barrels, which are surrounded by a water-tank, to keep the barrels cold. The latter are fitted with three buckets, with metallic packing, and driven with a three-throw crank-shaft, at a speed of from 55 to 60 strokes per minute, and thus compressing the air to 30 lbs. per square inch; this enables the drill to bore a hole, at the rate of 1¾ in. per minute, into the hardest granite which is found in nature. Soft Yorkshire stone may be pierced at the rate of 4 inches per minute. There are several of these machines now at work in the Tincroft Mine, in Cornwall, and which are giving the greatest satisfaction, not only to the inventor but to the proprietors of the mine. In order to show the great advantage of this machine over hand labour, I may state that it does double the amount of work before accomplished by six men, in half the time, and at a cost of from 35 to 40 per cent. less money. In fact, I have a letter from Mr. Dœring and Capt. Teague, of the Tincroft Mine, in which they state that during the months of July, August, September, and October, 12 fathoms were driven by one machine, in ground where six men could not have driven more than 6 fathoms. There is also another great advantage in this machine over hand labour, and that is the very superior ventilation of the mine, caused by the exhaustion of the air at every stroke of the engine, so that the miner is largely benefited by the use of the rock-boring engine, not only by taking the most laborious part of the work from him, but by enabling him to breathe more freely, and thereby prolong his life.

Before concluding, I may again remark that the various working parts of the engine, such as the valve for working the piston, the turning gear, and the advance motion, not being directly connected to the piston, are not affected by its velocity, nor by the very severe shock it sustains in striking a hard blow upon the surface. Nevertheless, the various motions are performed with great regularity. The advance gear can only be put in motion when the engine has worked away a certain portion of the rock, and is enabled to make its full stroke. The motion of the valve is so regulated that the piston is enabled, in the back stroke, just to complete its full stroke without striking the cylinder cover. In the forward stroke, however, in order to take advantage of the full force applied to the piston, the valve is only changed in the moment of striking the blow; consequently, the greatest amount of work is done with a given power.

The following is a correct estimate taken from the actual working, or, more properly speaking, the driving of 1 fathom of level in hard jointy rock:—

Hand Labour.				Machine Labour.			
Miners' wages	£12	16	1	Miners' wages	£6	19	0¼
Smiths' costs	0	12	8½	Smiths' cost	0	5	5½
Powder	0	16	4½	Powder	0	13	5¼
Repairs		—		Repairs	0	18	7¾
Total	£14	5	2	Total	£8	16	6¼

This shows a saving of 5*l.* 8s. 7½d. per fathom, but the cost of keeping up a special steam-engine to drive the air-pump must be taken into account. In introducing this item into the calculations, we may allow that a steam-engine of 6-horse power would suffice for driving two boring-machines; therefore, the cost per fathom would be:—

Coals for steam-engine	£1	19	2	
Oil, tallow, &c.	0	0	7½	
Half the wages of engineer	0	12	8	= £2 12 5½

With such advantages, these engines I feel sure will in the course of a few years be generally adopted and used in every mine and quarry which requires blasting.

At the conclusion of the paper a discussion took place, which was shared in by Messrs. Keyte, Gibbon, Edmonds, Dewar, Stokoe, the Chairman, and others. Finally a cordial vote of thanks was awarded to Mr. Irvine.

The Royal School of Mines, Jermyn Street.

MR. WARINGTON SMYTH'S LECTURES.

[FROM NOTES BY OUR OWN REPORTER.]

LECTURE X.—The last lecture (said Mr. SMYTH) was devoted to the consideration of the irregular deposits in which ores are found, and I furnished you with a few of the most remarkable examples of some of these classes of deposits. You will recollect that I divided them into four groups, but there is another class which might be regarded as belonging to those contact deposits in some parts of Europe, which follow exactly the contact planes of the fissure between two rocks. As examples of these, I might mention the mines on the borders of Hungary and Turkey, and particularly the neighbourhood of what is called the "Iron Gate," where the Danube forces its way through rocky boundaries into Wallachia, and those also including the mining centres of Szaska, Oravitza, and Moldova. Passing over the Danube into Servia we find the same grand dyke of syenite going through the limestone and other rocks, producing metamorphic action, and yielding several of the metals occurring in the Banat, which comprise gold, silver, copper, zinc, and nickel. Then, in this country, where we derive large quantities of hematite iron ore from the limestone, or from amongst the rocks belonging to the carboniferous limestone series, they may, in some sense, be placed along with those which belong to the contact of two different rocks, as it is very noticeable that in those parts of the country where they are found we get a sandstone rock overlapping the carboniferous limestone, and it is only when we get this state of things, or have reason to believe that it formerly existed, that we find such remarkable results. Amongst the metamorphic or stratified rocks I stated that in the great foliated masses of Scandinavia, where, as a rule, those containing iron ore were extended out to a great length, those containing copper ore are broader and shorter, whilst both run more or less between the planes of foliation of these ancient rocks. I might also mention that they in places approximate very closely to the appearance of veins, but that there are ample reasons for the distinction which prevents them from being placed amongst veins. Then, another important group might be mentioned—those of Huelva, in Spain, adjoining the mining districts of Southern Portugal, from whence hundreds of thousands of tons of cupriferous iron pyrites, for the manufacture of sulphuric acid, are poured into the market. These deposits run more or less with the strike, and extend to an enormous thickness, but with a smaller length and depth. The smaller deposits are often of a distinctly lenticular form, and whether, when one of these has been exhausted, they may count on a similar deposit opening out again below and the resumption of its greater breadth if followed out in the same direction, is a problem yet unsolved, as the district will need operations on a large scale, and carried on over many years, to determine so uncertain a question.

I have already mentioned the extraordinary mine of Monte Catini, where they get certain rocks which are decidedly metamorphic along with substances commonly held to be of a crystalline, if not igneous, character, and the importance of that case I particularly dwelt on in consequence of a number of instances in this and other countries in which serpentine was held to be unfavourable to the production of copper. In 1837 one of the most experienced and intelligent of the Cornish mining captains paid Monte Catini a visit, and condemned the mine as not worth spending money upon, mainly because the workings came into a serpentine rock; but it has since been persevered with, notwithstanding this adverse opinion, and from 1837 to 1867 the mine has produced 38,000 tons of copper ore, the average produce of which was 35 per cent. of metal—so that the amount represents over 1,000,000*l.* sterling, a fact which ought to remove the prejudices existing in some minds against serpentine. I was obliged to be brief with respect to the very important series of irregular deposits in limestones, but I mentioned that they were associated with dolomitic limestone over a very large area, and the interesting question upon that point, which will naturally arise, is whether this kind of limestone has been so originally deposited, or whether it has been changed by metamorphic action over this great area, or only over a portion, and, therefore, contemporaneously with the formation of the ore. This, however, is a large subject, touching upon geological and chemical action, which would require a whole course of lectures for itself.

We will now consider some of the preliminaries or works which must precede actual mining on any considerable scale. Whether it is in a new or an old district there must be a great deal done in searching for the vein or lode, and this is comprised under the term of "costeaning." It is carried out by cutting trenches or sinking shallow pits. In these preliminaries large sums have sometimes been spent to very little purpose. When a miner gets into a new district, and especially if it is one in which there has been much disturbance of the earth's crust, and he has no previous records or experience to assist him, the work of investigation is both difficult and arduous, and considerable sums may be expended, only to produce disappointment. It behoves every mining agent, therefore, to be more than usually cautious, and he ought to carefully estimate the cost of these preliminaries, as well as the necessary machinery for pumping out the water, for winding the mineral, and for the triturating and preparation of the ores, before he ventures on any recommendations to his shareholders. The first thing to be done, however, is "prospecting," as it is called in the present day. The surface of the rock in which lodes are to be sought, and where they may be expected to crop out, is often covered with a considerable depth of vegetable soil or alluvial deposits, which are sometimes derived from the neighbourhood, and at others washed from a considerable distance. In Lancashire, for instance, from 30 ft. to 100 ft. of clay and sand have been washed from a distance, and laid upon the coal measures, and so in metallic districts such overlying material is often many feet, or even fathoms, thick. All searching operations must, therefore, be slow, and expected to vary from a few days to months. If there are only a few trenches to be dug, no great amount of time need be consumed; but when the operations of boring or the employment of machinery are necessary then the period is more extended. A consequence of this superficial cover is that the greater number of mines have not been discovered by the employment of these expensive processes, but by accident. It is a notorious fact that only a small number of mines can be traced back to a scientific exploration. In some cases the lode may be revealed by the course of a river, or it may be plainly seen on the face of a cliff; in others a piece of veinstone or ore is brought up to the surface by the ploughshare. In many cases persons fishing, and particularly when the streams are low, have obtained pieces of shining material, or stones heavier than usual, or otherwise remarkable, which have led to an investigation, and the discovery of lodes. Thus, one of the most promising little mines in the Plynlimmon district was discovered four or five years ago by some boys who were on the look-out for trout, and observed pieces of ore in the stream.

In searching for minerals in the stratified rocks a knowledge of geology is especially requisite, and governs many of the points to be considered, such as the relative antiquity of the rocks, and the conditions under which certain minerals are likely to be met with. There are two or three points which come into practice in reference to the search for coal to which I will refer. Thus, when there is a strong ferruginous or ochreous deposit in the pools of water in a district it is frequently said to be a sure indication of the presence of coal; but statements of this kind must be taken with some reserve, as there are many circumstances under which it would have no significance at all. If it should be a district where the carboniferous measures exist, it is no doubt an indication of high value, and if the reason be asked it is not far to seek. When there is coal resting on a bed of impervious clay, and the bed over the coal, or the seam itself, contains iron pyrites, subject as that mineral always is to rapid decomposition, which gives rise to the formation of sulphates, and these when exposed to the air change again to the hydrated peroxides of iron, and are thrown down in the pools of water at the surface or in springs and streams, in such a district are no doubt indications of the presence of coal; but if you go into regions where, from the nature of the strata, there is no possibility of coal at all, you may still find similar appearances where iron pyrites, subject to its usual decomposition, is found, associated with impervious beds. It is unwise, therefore, to trust, without further indications, to outward and visible signs of this kind, which may lead to nothing. Search has been sometimes made in the Silurian rocks, where nothing has been found but black shales, similar to those found in the coal measures, but quite useless. I need hardly point out to you that now-a-days, when geological researches have been carried out to such great lengths, men have no right to give their opinions on these subjects unless they are prepared by some amount of scientific knowledge to do so, and what fifty or sixty years ago might have been allowable would not be tolerated now. Other indications of this kind may be mentioned, as, for instance, the occurrence of salt springs, which, no doubt, are sometimes a clue to large bodies of salt below the surface, but salt springs having been found on the coal measures have sometimes been regarded as indicating the presence of coal, although I believe they have generally led to no satisfactory results, being simply the rushing out of saline waters, which have passed through porous rocks from the places where the sandy strata were impregnated with salt. In other cases they have been found to have a true and close connection with deposits of rock-salt, and in many instances brine springs are of more value than the rock itself, because the latter may have its salt deposits associated with many impurities. Springs of petroleum and naphtha are often wrought for their own sake, but they have also, in some cases, led to the discovery of beds of asphaltum—a mineral pitch of great value. Again, gaseous emanations are a valuable indication of the presence of certain rocks; and thus fire-damp, as it is called, or carburetted hydrogen, had sometimes led to the discovery of coal measures. Emanations of this kind have been noted in some districts of South Staffordshire and in Scotland, and several remarkable instances are mentioned in Nova Scotia. Appearances of this kind are not, however, confined to coal districts, as they have been observed issuing from the bands and belts of rock salt in Poland, at Wielicaka, and in the Marmaros, in Hungary; and, in the case of the oil wells of Pennsylvania, there are often great outbursts of gas and water from the joints and fissures from which the petroleum is derived. In China these occurrences are very notable, and the Chinese, directed by them, manage to sink bore-holes towards the coal measures, through the secondary rocks, and freeing the gas in what they call "fire-wells" employ it as fuel for evaporating the brine to make salt.

I now pass on to consider several points of importance in respect to the earlier steps taken with a view to mining operations in any given district. We might have to deal with a neighbourhood where there is already a good lode known and worked, and it may, in that case, be of importance that we should discover its course, which may be done frequently by tracing the back or outcrop. Secondly, we may have to try and discover if there are any, and if so, what is the character of the branches or lodes parallel to that already known and worked? Thirdly, we must see what is requisite in the exploration of new ground. The two first points may be taken together. Where a lode has already been worked, and is known to be enclosed on both sides with the same kind of rock, we shall have first to make out its strike and dip. With stratified beds there is no difficulty in finding out what is above and below the bed of useful mineral; but still the first and principal task is to take the strike and dip as accurately as possible, or, at least, their average if we find the line to be very variable; and the more a bed or lode deviates from the perpendicular, the more trouble it will give us in following it across the country. The intervention of a valley often produces difficulties which nothing but a careful attention to the parallelism of the beds will overcome; and so we might, after such an interruption, look for the lode in the wrong place, in consequence of the apparent deviation produced by the ground being hollowed out by surface action or by actual depression. When, however, we come to the lode again on the opposite hill, we shall, probably, be able to see the whole nature and details of the case. Generally, however, it is a matter of solid geometry. The more vertical the lode is the more simple is the problem, and a deviation of 10° or 20° from the perpendicular will make but little difference, as it will even present an approximately straight line, and when there are groups of lodes, what is true of one is nearly always true of another. A different kind of problem suggests itself sometimes. When we are already working underground, it may be desirable that we should know where the outcrop exists. To ascertain this, we must accurately determine the angle of the lode with regard to the surface, and then it becomes again a simple geometrical calculation. Supposing we have a good observation of the inclination of the strike, and the lode is covered by not more than 6 or 8 ft. of alluvial cover, we dig a trench across the line of strike, at a well-selected point, and strip the rock bare. If it be 15 or 20 feet crop, we put down little pits or shafts, and drive from one to the other. If we have the case of a lode running between two different classes of rock, it is obviously more easy to deal with them if we have a similar rock on both sides; as, for instance, if we have a granitic stone on one side and clay-slate on the other, the space to be searched will be greatly narrowed. One or two points may be mentioned as important in following the lode, or even a stratified deposit, over the surface of the country. Take, for instance, a country like the gold districts of Victoria, where, as at Ballarat, there is a considerable development of granite rock, along with clay-slate, but where it is also overlaid with alluvial deposits of great thickness, associated with bands of lava. In other places these stratified alluvial deposits are overlaid by rocks, and the question arises—and a very important one it is—whether the workings carried on here successfully for a length of time should be extended below this rock. A Spanish gentleman was the first in that district to point out in print that there might have been lava poured over the surface of the country after and upon the alluvial deposits; and this has proved to be the case, thereby greatly enlarging the extent of auriferous area. In Derbyshire the magnesian limestone lies unconformably on the coal measures, being a superstratification of a newer formation, but the case might be entirely different with a rock of a different character. A study, then, of the age and character of the local rocks is of great importance.

We may have besides, in addition to what I have been stating, to deal with the remains and traces of ancient mines. These may have been isolated workings, or portions of workings, or a number of mines grouped together. When we look at the depths which the old miners were able to penetrate, we shall understand the difficulty there is in judging of the possibility of re-opening old workings with advantage. There are some remarkably deep shafts, which can boast a very considerable antiquity. Certain shafts in Bohemia and the Tyrol stated to be 400 and 500 fathoms deep (though, probably, there is some error in that measurement), were sunk 200 years ago. The Samson shaft, in the Hartz, is another remarkable shaft, while, perhaps, the deepest in the world is that of Sacré Madame, near Charleroi, where they sunk 3410 feet in search of coal. Amongst bore-holes the deepest is that of Creuzot, which was sunk to 3017 feet. In England the deepest copper mine shaft is that of Tresavean, and the deepest colliery shaft that of Dukinfield, both of which are much shallower than the great depths attained on the Continent. It is obvious, however, that at much less depths than 300 fathoms, after a few years the accumulation of water in the shaft and in the workings, the roofs and sides of the levels must be greatly softened, and perhaps broken down, so as to make it extremely difficult to restore them; and in some kinds of soft and yielding rock it would be impossible to re-open workings long closed with any prospect of advantage. With regard old mines, it would be of the greatest advantage and interest if we had records giving an account of how the workings had been carried on, but many countries are deficient of these. It is much to be regretted that even now in this country the commercial results of attempts to recover old mines are not recorded, and that no means are adopted, and no arrangements made, by which such results could be placed in a regular registry for the consultation of those persons who may be interested in them at a future day. If we had (and especially in coal districts) proper plans, duly registered, of the abandoned mines, we should escape a frequent source of the loss of human lives, and not have so many garbled statements, and so much merely traditional evidence, upon the faith of which much capital has been expended in the resumption of old mines, without any profitable result. Ranges of old shafts are recognisable in some districts by means of crater-shaped openings on the surface, or by means of burrows or heaps of rubbish piled up around them. If we go into any of the old districts worked by the Romans, we shall find that that enterprising people opened mines on a very large scale. In the south-eastern provinces of Spain, in Italy, and in Eastern Europe, may be seen old mine shafts running for long distances, and the tops of the shafts being generally broken in, deep depressions mark their line; some of these may be of great antiquity, others no older than the last century. When, however, we meet with an appearance of this sort, we have, first, to determine what is their real character; and, secondly, whether it will answer if we attempt to re-open them. Sometimes appearances of this kind are not old shafts at all. Thus in the mountain limestone formation of England, in Carniola, and other calcareous regions, may be seen lines of crater-like depressions, much resembling the shafts of old mines, but which are caused by the crowning in of the surface material, from the action of subterraneous springs, or streams, eroding and hollowing out the limestone. In the North of England hollows of this sort—"swallow-holes"—are sometimes 20 or 30 feet deep, and in some foreign districts 40 or 50 feet, and if they occur in the midst of heaps of broken stone have a strong resemblance to these old shaft hollows. When we have, however, to deal with what are undoubtedly old shafts there are several points to be carefully considered before we begin to work upon them. We must see what is the prevalent directions of lodes in the district, and how far the old heaps are coincident with it. We must make a careful examination of the heaps themselves, and see if they are simply composed of rubbish, or if any vein-stone or ore is to be found amongst it. If the lodes of the district properly run east and west, we may conclude whether the shafts were opened on the main back of the lode or on a cross-course, or whether they may be only air-shafts belonging to an adit level. Again, if we want to judge of the amount of water likely to be met with, and thence of the probable expense of operations, we must search for the lowest place of exit, and judge by what runs out as to the quantity which may rise from interior sinkings, or which may drain down from the upper ground to the level of an adit. Furthermore, these various heaps must be examined as to whether their upper portions are as they were originally left. If we find a noteable proportion of ore, we may conclude the old men left the mine in a tolerably rich state. We may have to consider whether if there should be a great outflow the old men had been beaten out by the water, or if there is very little water we may come to the conclusion that they worked the mine pretty deep, and were, perhaps, disturbed by the operations of war or political convulsions, and in either case the prospects of re-opening the mine will be tolerably favourable. When we get to the bottom of the old mines it is not found in one case out of fifty that the old levels have been left rich enough for taking away ore, and nothing can be done without opening fresh ground. Nothing, however, is more speculative than re-opening of old mines, of which the depth and extent are considerable, and it may be that an expenditure of thousands may be incurred before the bottom of the workings is reached. The only reasonable expectation of success must be founded on having a sufficient capital to enable the adventurers to sink their shafts and drive their levels beyond the old limits of the mine, upon what is called "tutwork," or piecework. Unless under peculiar circumstances it is not likely the old miners would leave unwrought ores that were easily attainable, although many mines of this kind may have a tolerable promise of success by entering upon a proper and miner-like course of fresh exploration of the ground, which, nevertheless, are prematurely abandoned for want of sufficient capital for a systematic recommencement of the work, and are, in fact, under some unhappy "limited liability" direction, given up as hopeless at the very juncture when a reasonable prospect of good results begins to open.

LECTURE XI.—There are numerous mines in Europe which have, there is no doubt, been worked, more or less, from the time of the Romans; and when we look at such a district mapped on a small scale we may think that it has been thoroughly worked out, but when we come to examine the same district mapped on a large scale, or, still more, if we examine the country ourselves, we shall find that only a small portion has been developed, and that there are many tracts of surface containing lodes which have not even been tried. There are, however, many instances of old mines which may be worth resumption. I mentioned in my last lecture some of the considerations which ought to guide us in attempting to re-open places of this kind. There are no plans or records in existence, and, indeed, documents of this kind are seldom to be had anywhere of greater age than 30 or 40 years. I pointed out to you that serious mistakes had occurred, even when documents were attainable. I may mention a case which has attracted more attention, perhaps, than any other, which occurred in the western part of Cornwall. The Wheal Vor Mine, near Helston, had been very successfully worked down to the depth of 300 fms. for tin. It was then abandoned, and within 20 years afterwards a new company was started, to re-open it and resume operations. There were miners living in the neighbourhood who had worked in it before, and there were plans and documents obtainable which related to the old working, so that great hopes were entertained of success. Large pumping machinery and powerful steam-engines were erected, and in a short time from 200,000*l.* to 300,000*l.* had been spent, and even then they had not seen the bottom of the mine. When at last, after many breakages and interruptions, they did reach the bottom, where, according to expectation, they were to get as much good tin ore as would make up for all this heavy outlay, they by no means found the state of things which so many witnesses had described as existing. I went to the bottom of the mine myself, and found that the workings had been conducted upon such an unsatisfactory method that it was impossible that the lode (of the quality which was there exposed) could be made to pay by the continuation of those processes which had been in use before, and that the only way to deal with it would be to expend, perhaps, 50,000*l.* or 60,000*l.* more capital, and two or three years more time in sinking shafts and driving out galleries to a

considerable length, all of which must be done before the mine could be worked into such form as to offer any prospect of profit. It was, however, found impossible to get shareholders to advance this additional money; the whole was abandoned, and the water allowed again to fill the workings. With such cases before their eyes, it is curious, nevertheless, to see mining adventurers have not sufficient discretion to avoid the misunderstanding of such perilous undertakings; and we may see even at the present time repetitions of this sort of thing, and promising, though delusive, prospectuses, holding out confident expectations that wealth will be at once discovered simply by pumping out and re-opening this or that abandoned mine. A moment's reflection, however, is sufficient to show how unlikely it is that our forefathers would leave a mine in a state of riches, or fail to extract all the ore that was in sight before they abandoned it, and therefore, how necessary it is to have in reserve a sufficient capital for the fair laying open of fresh ground. Since limited liability companies have come into vogue not a few have been got up for purposes of this kind, and expectations have been held out of immediate returns; but of those which have done best I am not aware of any which have realised those expectations, while by far the greater part have proved disastrous failures. Leaving these cases, which arise from persons completely misunderstanding the problem they have to solve, let us proceed with the appearances at the surface of old workings, on which we have to form a judgment. I have already mentioned the shafts, the levels, and the heaps at the mouths of the various workings, and some of the circumstances by which we might be misled, to which others might be added. Thus, it is improbable that the heaps will be in the same condition as when they were left. If they are in proximity to a populous district, and suitable for road stone, they may have been greatly reduced in size, leaving it to be inferred that because the heaps are small the workings have not been extensive, while the very reverse may be the case. Again, levels may have been driven as adits at two or three different points on the hill side, and unless we are sure which it is that carries off the water we may judge by one in which there is no great flow that the ground is not watery, when in reality it may be very much so. Great attention should be paid to the composition of these ancient heaps, and particularly of heaps of slags, as sometimes large fortunes have been made by re-smelting these ancient slags, particularly if they are the residuum of lead ore. There is one other point to be noticed in speaking of the resumption of old mines. It is sometimes preferable to make new excavations, rather than attempt to open the old ones. Thus, in soft ground the admission of water into the excavations invariably brings the roof and sides together, so that it is better to get in under the ancient workings, and thus work the same deposit, leaving a sufficient barrier between the new and the old works. This is frequently attempted on a smaller or larger scale, as the case may be; but connected with it is the danger of cutting into ancient workings which contain water. It is almost impossible that there should be good plans of those workings when of considerable age, and there is, therefore, always a great risk. A very interesting case of this kind has lately occurred at the St. John del Rey Mine, in the Brazils. A fire took place a year ago, and the heavy stulls, or timber struts, having been consumed the sides have broken in, and the workings, to 160 fms. deep, are filled with debris, through which it is dangerous to attempt to sink; and the only way to surmount the difficulty is to make new shafts at the side, and leaving, of course, a sufficient thickness between, thus again reach the rich deposits of ore in the depths below.

We pass on now from ground about which we already know something to those considerations which suggest themselves in new, or what is called virgin ground. This may be in districts which are themselves entirely unknown, as, for instance, in the interior of South America or Australia, and in some European States. Take, for instance, the map of the gold districts of Australia, and we see that the workmen, or new adventurers, finding the ground occupied push on up the country by thousands, and, perhaps, tens of thousands, from Melbourne towards Ballarat and Castlemaine, and have, therefore, to examine the intermediate country by what is called "prospecting." Even if we look at the geological map of Cornwall and Devon (exhibited), we shall see many square miles without any known lodes existing, as on Dartmoor for instance. In a case of this sort we have the advantage in England of knowing the class of rocks we are searching amongst, and the relation they bear to the existence of ores, and so we go armed with an experience which may save us both time and money. It is evident that in this sort of undertaking we must bring in the aid of geology and mineralogy—the former to tell us the probable classes of rocks, and their relations to each other; and the latter to clear up to us the nature of the minerals we may have the good fortune to find. These are reliable data on which to start, and which may guide us in our work. We find on looking back to former times that there were strange rules and plans followed, to which we profess now-adays to attach no value, but to some of which there is still left a little leaning. The old men held that productive veins ought to be sought near rivers or on the sea side, from a sort of notion that the vapours from large bodies of water had something to do with the deposition of ores, but this is no longer a belief, and especially since the discovery of large deposits of the most valuable kinds far away from all water. Then, again, they said that productive veins must be sought for on the secondary hills, rather than amongst the higher peaks of a central region. An examination of the principal mountain chains seems to bear out this view. If we compare our own mineral districts, and many of those on the Continent, we shall see that while the coal and iron-stone miners seek for country free from disturbances, the miners for metalliferous ores seek for districts which have been disturbed, but not too much broken up and disjointed, as it were. Neither of these promising conditions are, as a rule, found in the higher ranges of mountains, with their jagged heads and bold gigantic masses, standing out as though to defy the elements, but in the secondary, or rounded portions, or shoulders as it were, in which the backs and cross-courses are not so very considerable, but coincident with the occurrence of valuable minerals. Again, when they have the choice of different sides of a hill some miners affect to prefer the sunny side, or that facing the south, as likely to be more productive than the lodes on the other. I do not think, however, that there is much reliance to be placed on this, although I could point out curious instances of that sort of distribution on a large scale, because there are equally abundant cases on the other side. Thus, if we look to the eastern part of Cornwall the granite elevation stands out like a large boss or hill, and it is a curious fact that on the south side, between Liskeard and Bodmin, the lodes are numerous, while on the north side scarcely any are known to exist. It still, however, remains a question whether the north side should not be explored. Again, near St. Austell the same thing occurs, but when we come lower down we find on the south side of the granite, near Helston, but very few lodes off that rock, while the north side is the richest mining district of the West of England. We may conclude, then, that this theory is one of no value, and that our judgment must be formed by what we discover from actual examination of the veins themselves. Particular instances might be cited in the same way as to fractures of the rocks, the more fractured being sometimes the most productive, and at other times the reverse. It is, however, seldom that we have a lode running alone, there being generally a number of parallel lodes, and often more than one series, each series, although in opposite directions, running in groups. Another point frequently discussed amongst miners in prospecting the ground is whether it is better, and involves a greater probability of success, that if the lodes run parallel to a hill the veins should dip with it or against it. The Veta Madre, in the mines of Guanaxuato, famous as one of the richest lodes ever discovered in any part of the world, dips with the hill at an angle of 40°, and it is notable that where it is intersected with certain little gullies it is much richer than elsewhere. Again, in the mines of Fresnillo, also situated in Mexico, in the province of Zacatecas, the chief lodes course N.E. and S.W., nearly parallel to the main ridge of hill, and the general underlie is similarly with the hill. In the Great Consolidated Mines, at Redruth, the lodes are noticed to be most productive when they dip with the hill, and other instances, both at home and abroad, might be cited. The exceptions, however, are so numerous as to make this theory almost worthless. Near Callington we have this curious fact, that where the hill at Kelly Bray dips both ways, the stratification of the rocks remaining the same throughout, the lodes of Kelly Bray and Holmbush underlie oppositely. This is not a common case, and I do not know that it has any real relation between the crest of the hill and the lodes, one of which, that of Holmbush, has been worked to near 200 fathoms deep from the surface, with a large production of copper ore. Again, miners say that when the lode dips against the hill there is less probability of success, because the weight of the hill will be too much for it, if compared with those cases where the vein is said to "want cover;" this, however, must evidently depend upon local peculiarities in the character of the lode and the country, and is so far accidental as not to offer grounds for generalisation.

Another point has, at various times, attracted great attention, and that is how far "latitude" affects the productiveness and nature of minerals. Thus it used to be held that coal was only produced in temperate latitudes; that is to say, neither near the equator nor far to the north; but circumstances have dissipated this notion, as coal has been discovered in latitudes as high as Spitzbergen, and good coal has also been found much further south than heretofore it was supposed to exist. Again, it was formerly thought that gems and gold belonged to the tropics; but when diamonds have been found so high up as the Ural Mountains, and gold so largely in Siberia (while gold is also found as far to the south as Australia, and elsewhere), it can no longer be said that latitude has any connection with either metallic or non-metalliferous minerals.

It has been asserted by old authors and old miners, of whom some are yet living, that the presence of metals is indicated by luminous appearances, or corruscations, like flame playing along the lodes. Dr. Pryce, in his work, devotes considerable space to this subject. It is said that the Wheal Buller lode, the United Mines and Budnick lodes, near St. Agnes, exhibited these appearances, and were thus discovered. I remember seeing, a few years ago, a statement put forward, by apparently creditable persons in America, that copper mines in New Brunswick, indicated by these lambent appearances, had been noticed, and quoted in the *Mining Journal*. It is, however, rather curious that in these modern times persons who have seen these phenomena become more and more scarce, although I confess it is difficult to withhold credence altogether from these statements. Another belief is that snow and hoar frost will melt sooner on the back of a lode. This, however, is a very probable circumstance, as the iron pyrites, which is commonly associated with the other minerals, and forms part of the gossan, produces decomposition, which might raise the temperature of the mass. Moreover, the material, under any circumstances, will be different to that of the soil of the country at its side. Again, it has been observed that along the back of a lode there is but little vegetation; and it is reasonable to suppose that the sun striking upon it would have a different effect than upon the grass about it growing on vegetable soil. The reverse is the case when the line is marked by a depression of the surface, and then a little runlet of water is often found, and the vegetation more luxuriant. All these marks may serve to trace the line of a lode across the country, and are often serviceable. I am less inclined to believe that particular trees grow along the backs of lodes; but no doubt botany may assist us in the discovery of salt, as there are certain plants known to be closely connected with saline deposits, and occurring only at the sea-side, or where there is rock-salt. Of these may be mentioned the arevaria rubra, the aster-trifolia, the salicornia, and the salsola. It is asserted that certain plants are associated with the presence of iron, but one should be slow to put faith in assurances of this nature. Some persons say they can detect the presence of certain metals by the sense of smelling, and it certainly does not require a very acute nose to recognise the presence of iron pyrites. If you should visit the Vale of Avoca, which is productive of such enormous quantities of iron pyrites, or parts of the Perran copper district, near St. Agnes, in Cornwall, or of the Devon Great Consols Mine, you will get, by smell, the most decided evidence of the presence of large quantities of pyrites. One of the most startling beliefs of this kind which may be traced in mining districts all the world over, and in which many persons put faith even in these days, is that of the "dowsing-rod." This belief started into existence in about the eleventh century, but it was for a long time coupled in the minds of the people with the practice of the Black Art, so that its claims were never fairly considered before the time of Agricola, who devotes a chapter to it. We find, however, men like Dr. Pryce go great lengths in support of the "dowsing-rod," and, in his day, its principal practiser was Mr. Cookworthy, of Plymouth, one of the great practical chemists of that time, and the man to whom, more than anyone, is due the establishment of those china-clay works in Cornwall, which do such an enormous trade, and which have placed Great Britain in so high a position for its manufactures of earthenware and porcelain. Several authors have touched on the "dowsing-rod," and some of them at considerable length. A curious little book on the subject was published in Paris in 1702 by M. de Vallemont, a French *savan*, called "*La Physique Occultez*" and it is only a short time ago since a most interesting treatise was written by a famous philosopher and chemist, M. Chevreuil, "On the Baguette Divinatoire (as the French term it); its use," &c., in which the divining-rod is examined from a philosophical point of view, the author, however, evidently believing that discoveries have been made by it. In the earlier days of physical science the Hon. Robert Boyle put questions on this subject in the "Philosophical Transactions," but he rather states what was then asserted than anything of his own respecting the "rod." The "dowsing" or "divining" rod is a forked stick of some fruit-bearing wood, generally hazel, held by the extremity of each limb of the fork in a peculiar way. The "dowser" then walks over the country he is to try, and when he approaches a mineral deposit the thicker end of the fork turns downwards, in spite of all the efforts of the holder to the contrary, and points to the lode. There is no doubt that, owing to the way in which it is held, when once it begins to move it has a mechanical tendency to turn. The dowsing-rod is used in all the counties of Europe, except Germany, where it has fallen into complete discredit. On the other hand, it holds full sway in a new country, America; and in France, so lately as 1862, an ecclesiastic was making a large income by its use for the discovery of springs of water. I saw in the *Mining Journal* only a short time ago a statement by a mining agent that a new lead lode, of great value and promise, had been discovered at Chiverton by its means. It may be, however, that in some of the mineral districts where these discoveries are made there are so many lodes that it would be even more remarkable if it did not point near to something; and we hear only of its successes, its failures are not spoken of. I have, however, a curious and well-authenticated statement of the discovery of a dislocated lode by a dowser, and of one who, although blindfolded, traced the zig-zag course a particular lode was afterwards found to take underground. These are given to me as real facts, but I cannot myself vouch for them. I prefer to recommend the advice given by Agricola, one of the most sensible of writers on mining, who says—"Miners should be good men, and true; and I advise them to put the rod aside, and give themselves to the study of that which appears in nature as supplying the best indications of the existence of lodes."

Supposing, however, that no opportunity was afforded of seeing the lode, from the interposition of the bed of a stream, or broken ground, or any similar cause, the usual course will be to examine the bottoms of the gulleys and the shallows of rivers in search of certain rolled stones, which may have come off the ore itself, or be some substance connected with valuable minerals. Having found these, you will follow the course of the stream upwards in search of the place from whence they came. If these stones (which are called "shode-stones") are composed of fluor-spar or barytes, they will indicate the nature of the mineral to be expected in the lode; and as we pass higher up the stream, and nearer to their source, they will be larger, more angular, and less rolled or water-worn. At length, as we trace them up the stream, they will, probably, disappear, and then we must begin to look about for their source in the tributary streams and rivulets. If we find that they come down the main gulley, we must search for the place of their first appearance on the banks, and see if they come from the hill or elevated ground adjacent. For this purpose, trenches at right angles to the course or strike are cut, with a view to intersect the run of the lode, and, if unsuccessful, then in the reverse direction, until the outcrop is found. This sort of examination is materially assisted by the action of water in the Californian districts, where what is called "hydraulic mining" is carried on. Thus, for the "washing" in the mountain limestone districts, water is collected at a considerable elevation in reservoirs; and then opening the sluices, it is permitted to stream down the sides or channels prepared beforehand to direct its course; and this process—sometimes often repeated—washes away the superficial deposits of earths and soils, and lays bare the outcrop of the lode. Sometimes the alluvial deposits thus washed away contain pieces of orey mineral, which are worth collecting. A considerable quantity of lead ore in iron districts has been obtained in this way, besides effecting the discovery of the run of the lodes. Dr. Pryce calls "shoding" a science, and laments that in his day it was greatly lost sight of, in consequence of enterprise being directed more to the known localities than to those which were new. He recommends certain points to be observed in shoding, which, however, he says, are too frequently neglected. One point is—"If the shode is found in vegetable soil, the lode is not at hand, but if it lies deep, and is angular, the lode is not far off." I have seen where the shode-stones have been found near the surface—turned up, perhaps, with the plough-share—that the finders have set to work on that spot, and, perhaps, sunk a shaft, in the hope of securing the lode, but they have found none. The fact is, that in the lapse of years, pieces from the lode, especially if it should be on a hill side, will be removed by the action of gravitation, the distance depending on the inclination of the hill side, and the thickness of the alluvial cover; and I have known cases in which shode-stones have been found at a distance of from 20 to 40 fms. from the place where the lode really was. In judging, therefore, on points of this kind, there is great necessity for caution, and much observation of the physical nature and condition of the ground.

GEOLOGICAL SOCIETY OF LONDON.

Dec. 9: Prof. T. H. HUXLEY, LL.D., F.R.S. (President), in the chair.

Arthur Champernowne, M.A., Dartington Hall, Totnes, Devon; James Thomson, Glasgow; W. Chandler Roberts, F.C.S., Associate of the Royal School of Mines, Thurlow-place, Dulwich; John S. Winbott, M.A., Sandridge Vicarage, St. Albans; Lawrence Preston, Keynshambury House, Cheltenham; John H. Blake, Geological Survey of England and Wales, 9, Aberdeen Park, Highbury, N.; John Hewitt Wheatley, Abbey View, Sligo; Owen Rees, 26, Albemarle-street, W.; and Octavius Russell Fabian, 5, Bruce-terrace, Lordship-lane, Tottenham, were elected Fellows.

The following communications were read:—

1.—"Notes of a Geological Reconnaissance in Arabia Petræa," by H. Bauerman, F.G.S. The district to which this paper referred is that between Suez and the lower part of Wady Ferran, in the peninsula of Arabia Petræa, and includes the copper and turquoise mines worked by the ancient Egyptians. Iron, manganese, and copper ores are found near Nasb and Serabib el Khadem. The turquoise mines of Wady Maghara, which were referred to the same horizon, are among the most ancient monuments of the world. The author considered that the tools employed were flint chisels or flakes, and hammers made from pieces of a neighbouring doleritic lava. The flakes were supposed to have been mounted on wooden blocks.

Mr. W. W. SMYTH had found in Nubia, above the Catacombs, Red Sandstones overlain by limestone and Nummulitic beds. If the Red Sandstone, as seems probable from the fossils discovered by Mr. Bauerman, were proved to be Trias, a great point in the geology of Sinai and of the East had been gained.

Mr. BOYD DAWKINS enquired as to the evidence of the mines having been worked by the Egyptians.

Mr. EVANS was not satisfied that the flint flakes had been used in the manner suggested, as they would be liable to break off in the socket, and the hammers would not be worn away in the manner they exhibited by mere impact on wood.

The PRESIDENT commented on the similarity of the faunas of India and South Africa, and hoped that Mr. Bauerman's future researches might throw light on the ancient connection of these continents.——Mr. BAUERMAN stated, in reply, that he did not regard the white limestone as true chalk. He considered that the slabs showed conclusive evidence of having been chiselled by means of the flints.

2.—"On the occurrence of Celestine in the Tertiary rocks of Egypt," by H. Bauerman, F.G.S., and C. Le Neve Foster, D.Sc., F.G.S.

3.—"Note on the Echinodermata, bivalve Mollusca, and some other Fossils from the Cretaceous Rocks of Sinai," by Dr. P. Martin Duncan, F.R.S., &c.

4.—"On the existence during the Quaternary Period of a Glacier of the Second Order, occupying the 'cirque' of the valley of Palhères in the western part of the granitic 'massif' of the Lozère," by M. C. Martins, For. Corr. G.S.

On Wednesday, the following papers will be read:—1. "On the Basalt-dykes of the Mainland of India," by G. T. Clark.—2. "On the so-called 'Eozoonal' Rock," by Prof. W. King and Dr. T. H. Rowney: communicated by Sir R. I. Murchison.—3. "Notes on the Geology of China," by T. W. Kingsmill: communicated by the assistant-secretary.—4. "On the Auriferous Rocks of South-Western Africa," by Dr. Sutherland: with a Note by Sir R. I. Murchison, Bart.

SOCIETY OF ENGINEERS.—The next ordinary meeting of the society will be held on Monday evening, the paper on the Application of Steam to the Cultivation of the Soil, by Mr. Baldwin Latham, President of the Society, will be continued.

ELEMENTS OF MODERN CHEMISTRY.

The importance to the student of the natural sciences of acquiring as speedily as possible a sound knowledge of the leading principles of chemistry is universally acknowledged; yet it has hitherto been extremely difficult to obtain a practically useful work in a volume of moderate size. The conflicting views of the great chemical authorities as to the value or otherwise of the several theories propounded, have given rise to efforts on the part of recent writers to frame systems of their own, in the hope of obtaining a larger number of readers by effecting a compromise between the old notions and the new. The result has naturally been that an amount of confusion has been caused, almost sufficient to make the student abandon all hopes of understanding the professors, and strike out a new path, usually erroneous, for himself. An elementary text-book of chemistry, in which the new views are adopted in their integrity, and carefully referred to those previously held, has been almost entirely wanting; for the tendency which has existed to adopt views of one's own has not unfrequently led to the marring of a system which in its original form was considerably less objectionable. The Elements of Modern Chemistry,* recently completed by Dr. RICHARD L. MALY, of Olmütz, is intended to make available the increased knowledge which has been acquired, without advancing any theories the correctness of which has either never been ascertained, or is still contested.

Whether the student's after life is to be devoted to medical, pharmaceutical, or industrial pursuits, Dr. Maly's work may be studied with equal advantage. The physical properties of bodies, and the constitution of matter, including the atomic theory, Avogrado's theory, and the theory of equivalents having been explained, an excellent chapter on types is given, and the entire subject is so carefully elucidated that subsequent confusion will be almost impossible. In describing the multiple types, the arrangement of the primary, secondary, and tertiary forms of the hydrogen, water, and ammonia types, so as to display at a glance the nature of the differences and the mode of referring to each form and type, the various chemical compounds met with is admirable, and the same may be said of the remarks on the mixed types. From this the reader is led on to the question of combined radicals, and when the nature of these combinations has been thoroughly understood from the inorganic examples, similar examples met with in the organic branch of the science are given, so that the requisite knowledge is firmly fixed upon the memory. The laws of substitution, empirical formulae, allotrophy, homologous and isologous series, isomorphism, isodimorphism, chemical affinity, chemical metamorphoses, &c., are likewise described, and the study of these subjects, and of the laws of combination according to the different relations of bodies to each other—a chapter upon which completes the introductory portion of the book—well prepares the reader for the special instruction which follows.

In the special part of the work enormous advantage is gained, so far as assisting the memory is concerned, by arranging the elements according to their quantivalence, so that one is led from the simplicity of the hydrogen group (embracing, of course, hydrogen, chlorine, bromine, iodine, and fluorine), through the oxygen group (including sulphur, selenium, and tellurium), and the nitrogen group (with its phosphor, arsenic, antimony, bismuth, and boron), to the carbon group. By this means the organic and inorganic portions of the science are, to a great extent, kept separate until the student has made such progress as to enable him to study the more complex combinations with facility and success, the chapter on the carbon group (which embraces carbon, silicum, tin, zirconium, titanium, tantalum, and thorium) being followed by chapters on the univalent, strongly positive, metallic elements or metals of the alkalis; on the divalent metallic elements of the same class, or metals of the alkaline earths; on the divalent, less positive, metallic elements, including zinc and its compounds, and cadmium; on the trivalent, positive elements, or metals of the earths; on the metals of varying quantivalence; on the noble metals; and on the sexivalent metallic elements—wolfram, molybdanum, and vanadium, which completes the first division of the work.

In the second portion of the book the student is introduced more fully to alcohol, ether, aldehyde, and cetone, none of which bodies have been more than incidently referred to previously. Fatty bodies, in combination with univalent, divalent, &c., radicals, are in turn treated of; and there are likewise chapters on the allyl compounds, and grape sugar and dextrine series, in combination with alcoholic and acid radicals, &c.; on aromatic bodies, and their combination with oxygen and non-oxygen radicals; and on the various groups of more immediate importance in connection with medicine and with industrial chemistry. The work, as a whole, is one from which a very large amount of information can be specily obtained, whilst the nature of the information is such that it can be made readily available whatever special course of study may subsequently be pursued.

* "Grundzüge der Modernen Chemie für Mediziner, Pharmazeuten, und Chemiker." By Dr. RICHARD L. MALY. Vienna: Braumüller. London: Williams and Norgate, Henrietta-street, Covent-garden.

THE "POST-OFFICE LONDON DIRECTORY."

If any evidence were required of diligence displayed by the proprietor of the "Post-Office London Directory" to secure the utmost accuracy up to the moment of publication, the seventieth annual edition (that for 1869), just issued, would at once afford it. It is seldom, indeed, that so favourable an opportunity occurs for testing the ability of the publishers to make corrections at short notice throughout the dozen sections into which the work is divided, and it is satisfactory to find that they have proved their ability beyond question. The general election of members of Parliament coming so near the date of publication, must necessarily have prevented the printing of a single sheet in advance, for it must be remembered that the anticipation that the reformed Parliament would include tradesmen and working men, as well as those of the superior classes, rendered it almost impossible to judge in what part of the book corrections might become necessary. All the alterations rendered necessary by the elections appear to have been carefully and accurately made. Nor was the general election the only obstacle in the way of correcting the Directory—the death of the Archbishop of Canterbury, the resignation of the Conservative Ministry, the creation of a new peeress, the opening of the new Meat and Poultry Market at Smithfield, and various other important changes, have led to almost innumerable alterations, yet no inaccuracy appears to have resulted from making them. Vice-Admiral Robinson is properly described as a K.C.B. in the Official Directory, Viscountess Beaconsfield is inserted in the list of peeresses in their own right, the newly-elected Scotch peers are duly inserted in their proper places, and Viscount Gormansten is described in his new position of a baron of the United Kingdom. Dr. Tait is properly described as Archbishop of Canterbury, and the various changes consequent upon his elevation; and there is, moreover, a complete list of the members of the new Parliament, with their addresses and clubs. The size of the volume for the ensuing year is again somewhat larger than its predecessor, the number of pages now reaching very nearly 3000. With regard to the value of the Directory, it is so generally appreciated that it is almost superfluous to state that without the "Post-Office London Directory" no office can be considered to be properly supplied with necessaries.

THE MANUFACTURE OF WATCHES AND CLOCKS.—A most interesting and instructive little work, describing briefly, but with great clearness, the rise and progress of watch and clock making, has just been published by Mr. J. W. Benson, of 25, Old Bond-street, 99, Westbourne-grove, and the City Steam Factory, 58 and 60, Ludgate-hill. The book, which is profusely illustrated, gives a full description of the various kinds of watches and clocks, with their prices, and no one should make a purchase without visiting the above establishments or consulting this truly valuable work. By its aid persons residing in any part of the United Kingdom, India, or the Colonies, are enabled to select for themselves the watch best adapted for their use, and have it sent to them with perfect safety. Mr. Benson, who holds the appointment to the Prince of Wales, sends this pamphlet to any address on receipt of two postage stamps, and we cannot two strongly recommend it to the notice of the intending purchaser.

EXTRACTING GOLD FROM SULPHURETS.—At Mill city, Colorado, Dr. J. S. Seaton, of the McIntyre mill, is employing a simple method of extracting the precious metals from sulphurets. The method is very simple, the use of superheated steam or hydrogen gas being the agent used in desulphurising. A furnace is constructed with a circular ore chamber 6 feet in diameter and several feet high, with a fire-chamber at the bottom 3 feet deep. A pipe from a steam boiler passes in and bends over the fire, so as to superheat the steam, which then passes down to the bottom of the fire, under which it escapes from the perforated pipe so as to pass through the flames. The ore chamber is filled with ore, made into brick form, after being pulverised to an impalpable powder; the fire chamber receives a supply of wood, which is kindled; the steam is turned on, the door of the furnace is closed so as to keep the air from the fire, and in a few minutes the blue flames of the hydrogen pass through the ore to the top of the furnace. The sulphur, antimony, and arsenic in the quartz are driven off in combination with the hydrogen and oxygen, and at the end of eighteen hours the precious metals are perfectly free, and ready to unite with the quicksilver by any of the ordinary modes of amalgamation, the Swansea (barrel) process being the one used in this mill.

THE NEVADA SILVER MINES.—A curious fact has been lately brought to notice in regard to the Nevada silver mines. Heat, not water, is the chief enemy encountered after reaching a great depth, and instead of pumping out water, the companies have to pump in air. A Nevada paper says:—The increase in the heat in our mines is now beginning to give many of our mining companies more trouble, and is proving a greater obstacle to mining operations in those levels lying below a depth of 1000 feet, than any veins or 'pocket' deposits of water yet encountered. A number of the leading companies on the Comstock are now engaged in putting in engines to be used expressly for driving fans for furnishing air to the lower levels, forcing it through tubes of galvanised iron. With this great increase of heat in the mines comes a great decrease of water; in fact in our deepest mine, the Bullion, which has attained the depth of 1200 feet, not a drop of water is to be seen; it is as dry as a limekiln, and as hot as an oven. In the lower workings of the Chollar-Potosi Mine, which are a perpendicular depth of 1100 ft. beneath the surface, the thermometer now stands at 106°—a frightful heat to be endured by a human being engaged in a kind of labour calling for severe muscular exertion. Here, also, we find the water to have decreased, till there is at the present time a very insignificant amount, it being necessary to run the pump but four hours out of the twenty-four.

LONDON GENERAL OMNIBUS COMPANY.—The traffic receipts for the week ending Dec. 13 amounted to 10,634*l.* 18s. 6d.

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